4. Iterative Design Development

4.1. Introduction

4.1.1. The Design Manual for Roads and Bridges (DMRB) Stage 3 design of the Proposed Scheme, as described in Chapter 5, is an accumulation of all the design and assessment work undertaken during the Stage 2 assessment of alignment options, together with further refinement of the preferred route option during the Stage 3 assessment.

4.1.2. The Proposed Scheme design has been influenced by environmental information and assessment findings identified through the EIA process involving the environmental specialists working in tandem with the scheme designers, and in close collaboration with Transport Scotland and stakeholders. This has provided the opportunity to avoid or lessen potential environmental impacts though changes to the road alignment, land take requirements and the type/location of specific design elements. Measures included in the Proposed Scheme design to avoid or reduce impacts are referred to as 'embedded mitigation' (refer to Section 4.3 below).

4.1.3. This chapter provides an overview of the iterative design process, setting out the main environmental considerations that have informed the final DMRB Stage 3 design. It does not consider potential impacts of earlier scheme design iterations, although alternatives considered during development of the final scheme are described in Chapter 3.

4.2. Iterative Design Process

4.2.1. The design of the Proposed Scheme is iterative in that it has involved successive refinement to achieve a solution that addresses issues arising through the collation of new information on constraints or understanding problems identified as the scheme develops. Each design iteration has resulted in incremental changes that provide solutions, whilst being mindful of the overall scheme objectives, until an optimum DMRB Stage 3 level of design is reached.

4.2.2. For the Proposed Scheme, the iterative design process has involved the following:

- project team meetings
- development and use of an environmental constraints mapping tool, capturing survey data and information held by stakeholders
- environmental mitigation workshops
- a series of design refreshes
- stakeholder input

4.2.3. Project team meetings were held at regular intervals so that environmental disciplines had a formalised mechanism to provide feedback on any environmental constraints and on opportunities for addressing potential impacts associated with design proposals/refinements. This informed and influenced the Proposed Scheme design development.

4.2.4. In order to collate and share environmental and design information across the project team, a web-based GIS tool was developed. Known as WebGIS, it was a live tool accessible to all members of the project team and enabled easy access to a wide range of information including: environmental constraints (such as protected areas, habitats, features of cultural heritage interest, etc,); geotechnical and topographical information;

historic mapping, aerial imagery, site photographs and design information. Information was added and updated as necessary based on site surveys, desk studies, consultee information and design refreshes. The tool allowed data to be overlain to establish where there might be interface between the developing design and environmental constraints. It was therefore used extensively during the design process, particularly to inform the sifting of design options.

4.2.5. Environmental mitigation workshops were held during the Stage 3 design development. The workshops focussed on particular aspects of the design where contributions from specific environmental disciplines were required to discuss and influence the design development. Workshop themes included: road alignment and landscape fit, road drainage and watercourse crossings, structures, soil and peat management, and primarily included landscape, ecology, geology and hydrology specialists together with EIA co-ordinators and the members of the design team.

4.2.6. The iterative design process has also included stakeholder input, primarily via the monthly meetings of the A9 Environmental Steering Group (as described in Chapter 7 Consultation and Scoping), and other dedicated stakeholder consultation. ESG input in relation to the A9 Dualling programme as a whole has also been relevant to the Proposed Scheme, particularly around aspects such as road drainage design, flood risk, peat management, earthwork slope gradients and landscape fit.

4.2.7. Non-Motorised User (NMU) stakeholders have also influenced the Stage 3 design, via the NMU Forums (see Chapter 7 Consultation and Scoping) and meetings with the Highland Council Access Officer, Sustrans and Scotways. This, in addition to feedback from public exhibitions, has informed the design of NMU connections to and through the Proposed Scheme, such as the position of the National Cycle Network route and facilitating continued access to this and other routes through the inclusion of car parking provisions.

4.2.8. Discussion with affected landowners and local communities has also informed the Stage 3 design and has influenced the following:

- discussions with wind farm operators and Forestry Commission Scotland to help identify optimum locations and design detail for maintaining access to the Farr and Moy operational wind farms and for the future Glen Kyllachy wind farm, and also for forestry activities
- the A9 crossing of the Dalmagarry Burn incorporating an underpass designed to accommodate farm vehicles/activities and maintenance operations associated with the Highland Main Line (HML) railway and electricity infrastructure
- refinement of the Dalmagarry Burn realignment to reduce encroachment into agricultural land belonging to Dalmagarry Farm and flood plain areas
- access provision between Dalmagarry Farm and farming land on the opposite side of the Funtack Burn (the farms' existing access will be lost as part of the scheme design) - discussions with the landowner helped to refine the position of the access track and new crossing of the Dalmagarry Burn
- access provision between the communities of Ruthven and Moy - consultation with the Community Council informed the need to provide a local road connection between the two communities
- three variations of the position of Moy LILO were explored (in proximity to the existing Moy at grade junction with the A9) - an optimal position was confirmed, in discussion with Dalmagarry Farm, which reduced impact on agricultural grazing land whilst avoiding areas of priority peatland habitat

- the entrance to Dalmagarry Quarry was positioned, in discussion with the quarry operator, to avoid impacting on future extraction activities
- NCN7 was realigned to avoid impact on the property known as The Bellhouse
- Tomatin South junction – a number of options relating to the existing Tomatin South junction (grade separation/closure/partial closure) were considered in consultation with the local community at Tomatin and were also subject to a screening exercise in terms of environmental, engineering and safety aspects; it was determined, on balance, that the option to retain a Left-in/Left-out (LILO) arrangement should be taken forward
- bus stop locations have been informed through consultation with bus service operators and The Highland Council

4.2.9. The design of the Proposed Scheme has also been developed taking into account the A9 Strategic Environmental Design Principles set out in Appendix A4.1, which the project has sought to meet where possible.

4.3. Embedded Mitigation

4.3.1. The development of the Proposed Scheme has included consideration of the environmental constraints present within the scheme extents and has sought to mitigate, where possible, the potential for adverse environmental impact. Such mitigation has been embedded into the design of the Proposed Scheme and this has focussed on the avoidance of features of environmental interest/importance and on achieving best fit within the existing environment. The following overall principles were considered in identifying embedded mitigation:

- minimising potential impact on people and communities by avoiding direct encroachment onto property, optimising land take and facilitating access requirements
- horizontal and vertical alignments designed to be as close to the existing A9 as possible to minimise resultant earthwork embankments/cuttings and land take
- minimising encroachment into areas of ancient woodland and other sensitive habitat
- consideration of opportunities for potential variation of slope gradients to achieve best landscape fit and to reduce impact on ancient woodland
- minimising encroachment into areas at risk of flooding
- management of surface water runoff arising from the proposed A9 dual carriageway and side roads through appropriately located and designed drainage features
- avoidance of known areas of priority/deeper peat
- alignments designed to facilitate access through the A9 corridor for Non-Motorised Users with specific consideration to the National Cycle Network, Rights of Way and Core Paths

Land Take

4.3.2. The need to protect the Highland Main Line railway was identified early in the design process. A number of design iterations, including options involving new retaining structures to support the railway and the A9 were developed. Following appraisal in the Dalmagarry area, the design selected moved the A9 further to the east to avoid encroachment on the railway embankment in this location. This resulted in the requirement to realign a section of the Dalmagarry Burn, as it was considered that any adverse environmental impact of doing so could be appropriately mitigated.

4.3.3. Design iterations for the Tomatin Grade Separated Junction led to an option for inclusion of a compact junction arrangement. This design is appropriate for the relatively low turning movements and it has a reduced footprint with less land take and reduced landscape and visual intrusion. It also allows the existing Tomatin House underpass of the A9 to be retained. This junction arrangement was presented at the preferred route public exhibition in November 2016, with no adverse feedback received.

Landscape Design

4.3.4. The alignment of the Proposed Scheme and the design of associated earthworks has been developed through an iterative design process involving engineering, environmental and landscape specialists in order to minimise landscape and visual impacts, integrate the road with the surrounding landscape and provide a pleasant experience for travellers.

4.3.5. The landform sensitivity of the route was determined to identify particular areas that required a specific approach to the earthworks design. In these locations (summarised below) embankment slope profiles were steepened or slackened from the initial engineering design gradient of 1:3 (vertical:horizontal, approximately 18 degrees). At locations where a more naturalistic and integrated landform is required to help embed the Proposed Scheme into the existing landscape, slope profiles were slackened. At locations where safeguarding of existing landscape cover is desirable to maintain the pattern of the landscape and/or screening of the A9 to visual receptors, or other environmental constraints encountered, slopes were steepened.

4.3.6. Details of proposed slope gradients are provided in Chapter 13 (Landscape) and in Appendix A13.1, and summarised in the sections below.

Chainage 360-570 (SB)

4.3.7. The embankment adjacent to the southbound carriageway of the A9 has been steepened to a gradient of 1:2 in order to reduce the potential need for felling and maintain the wooded character of the landscape.

Chainage 1200-1650 (SB)

4.3.8. The embankment adjacent to the southbound carriageway has been steepened to a gradient of 1:2 in order to reduce the potential for loss of ancient woodland required to facilitate the Proposed Scheme.

Chainage 2290-2670 (SB)

4.3.9. The cutting adjacent to the southbound carriageway of the Tomatin to Ruthven side road has been eased out to a gradient of 1:6 in order to better integrate the Proposed Scheme into the adjacent landscape and allow for the potential for the land to be returned for agriculture.

Chainage 4390-4810 (SB)

4.3.10. The embankment adjacent to the southbound carriageway of the A9 has been eased out to a gradient of 1:4 to tie into the existing B9154. Significant peat deposits were identified as a constraint to the south of the B9154, in addition to the road itself, restricting the extent to which this embankment could be slackened.

4.3.11. Although slackening the earthworks to 1:4 at this location would result in the loss of some pockets of Annex 1 habitat, an area of Scottish Biodiversity List (SBL) habitat replacement planting can be provided in this location to mitigate for this loss.

Chainage 6830-7330 (NB)

4.3.12. The cutting adjacent to the northbound carriageway has been eased out to a gradient of 1:4 to integrate the Proposed Scheme into the adjacent landscape.

4.3.13. A basin of deep peat restricted the extent to which the earthworks could be slackened. Furthermore, this was identified as part of one of the larger areas of continuous semi-natural habitat within the context of the A9, therefore it was desirable to balance the need for landscape fit with the potential for loss of habitat.

Chainage 7280-8110 (SB)

4.3.14. The embankment adjacent to the southbound carriageway has been eased out to a gradient of 1:8 to integrate the Proposed Scheme into the adjacent landscape and allow for the potential for the land to be returned to agriculture.

Chainage 7600-8080 (NB)

4.3.15. The embankment adjacent to the northbound carriageway has been steepened to a gradient of 1:2 in order to minimise the loss of woodland.

Drainage Design

4.3.16. The locations and form of proposed permanent and temporary Sustainable Drainage System (SuDS) facilities have developed through a number of iterations informed by review of the proposals against environmental constraints, including ancient woodland and areas of deeper peat, and by consideration of landscape fit. Adjustments were made to a number of proposed SuDS locations to avoid/reduce the impact to environmental features and to shape the SuDS so that they fit into the existing topography as much as possible. These have been embedded into the design of the Proposed Scheme.

Minimising Impacts on Floodplains

4.3.17. Flood modelling has informed the road alignment, Dalmagarry Burn realignment, Dalmagarry access track position and NCN7 crossing of the Dalmagarry Burn west of the Highland Main Line railway.

4.3.18. Within the Proposed Scheme there are several areas subject to varying degrees of flooding, the most significant of which is the flood plain of the Dalmagarry Burn. To be consistent with best practice, the design has sought to replicate the existing flooding mechanisms, namely water coming out of channel at low points in the existing watercourse banks, and to avoid exacerbating downstream flooding.

4.3.19. The designed channel of the diverted Dalmagarry Burn (refer to Chapter 5) has been sized to accommodate a larger in-flow channel than existing which will result in adjacent fields being flooded less frequently. Low points in banks have been replicated in the proposed channel to allow flood waters to cover similar areas to those which currently flood. Depths of flood water on the flood plain are envisaged to be similar to existing in extreme storms.

Wildlife Permeability

4.3.20. The size of bridges, underpasses and culverts has taken cognisance of recommended dimensions to facilitate wildlife (deer, otter, bats, etc.) passage and also to allow mammal ledges to be incorporated, whilst not unduly affecting the proposed vertical road alignment that could have other landscape, visual and land take implications. This has involved a number of iterations informed by ecological survey findings, landscape appraisal, flood risk/hydromorphology and design standard/maintenance requirements.

Enhanced Lay-bys

4.3.21. As part of the Proposed Scheme, lay-by locations/functionality was carefully considered. It was proposed to increase the segregation island between the A9 and parking areas within lay-by locations from 1.8m stated in the DMRB TD69[i] to 4m which would also increase the overall length of the lay-bys. These 'enhanced' lay-bys were proposed to enhance safety by increasing the distance of pedestrians from the live carriageway and therefore increasing the enjoyment of any views and facilities. The islands could also be planted so as to create a green buffer area to integrate the lay-bys into the adjacent landscape.

4.3.22. An iterative assessment was carried out that considered locations for proposed lay-bys in terms of engineering/safety and environmental impact. The potential locations of lay-bys were restricted by horizontal road alignment for the Proposed Scheme and also by close proximity to proposed junctions or other existing lay-bys. This resulted in two enhanced lay-bys being proposed as part of this scheme, one northbound at chainage 8150-8400 and another southbound at chainage 7370-7600 (refer to Figure 13.8v).

4.3.23. The northbound lay-by location was determined by the distances between junctions and alignment criteria. It is proposed that the parking area will be 100m long which is the maximum permitted length. This is at the same location as an existing Type A lay-by which provides access to the existing forest tracks to the south of the A9 and is currently used by NMUs. Replacing this lay-by with an enhanced lay-by and link to the existing tracks maintains the recreational access to the forest and beyond.

4.3.24. The southbound location was also determined by alignment criteria and was moved further south to avoid being directly opposite the proposed northbound lay-by and to be further away from the existing Type A lay-by on the existing dual carriageway. It is proposed that the parking area will be 100m long. This location also gives an opportunity to include a viewpoint towards the Allt na Slanaich wooden viaduct to the north of the A9 as well as the hills to the north. The lay-by will also include for a Police Observation Platform.

NMU Access

4.3.25. A number of iterations of NMU access arrangements were developed as informed by consultee feedback and site visits, whilst taking cognisance of good design practice for NMU routes. The following key measures have been embedded based on iterative design:

- NCN7 was routed along a similar line to the existing NCN, adjacent to the A9 northbound carriageway, so that the majority of the route through the Proposed Scheme could remain segregated from road traffic (with the exception of occasional Estate/farm and Network Rail access).
- The need to make an NMU connection between Ruthven Road and the B9154 running through Moy was identified, which will allow access to the proposed new bus

stop at Moy LILO. An access track (shared with Dalmagarry Farm) is therefore embedded into the scheme design.

- The closure of the existing northbound lay-by just south of the A9 crossing of the Dalmagarry Burn (approx. chainage 3300-3500 on Figure 5.3d) was identified through consultation as having an adverse impact on users of the path network to the west of the A9 who use the lay-by to park. A new parking area off the A9 on the Dalmagarry farm access track to/from Moy LILO has therefore been embedded into the design.
- The closure of the existing forestry access track junction (at grade with the A9) and the A9 northbound lay-by at Allt na Slanaich (chainage 8300 on Figure 5.3g) was identified through consultation as having an adverse impact on users of a Right of Way who use the forestry access track to park. The proposed new A9 northbound lay-by will therefore provide capacity for car parking and a path from the lay-by will connect to the forestry track.

4.4. References

[i] Highways England et al (2007); DMRB Volume 6, Section 3, Part 3 TD 69/01 The location and layout of lay-bys and rest areas.